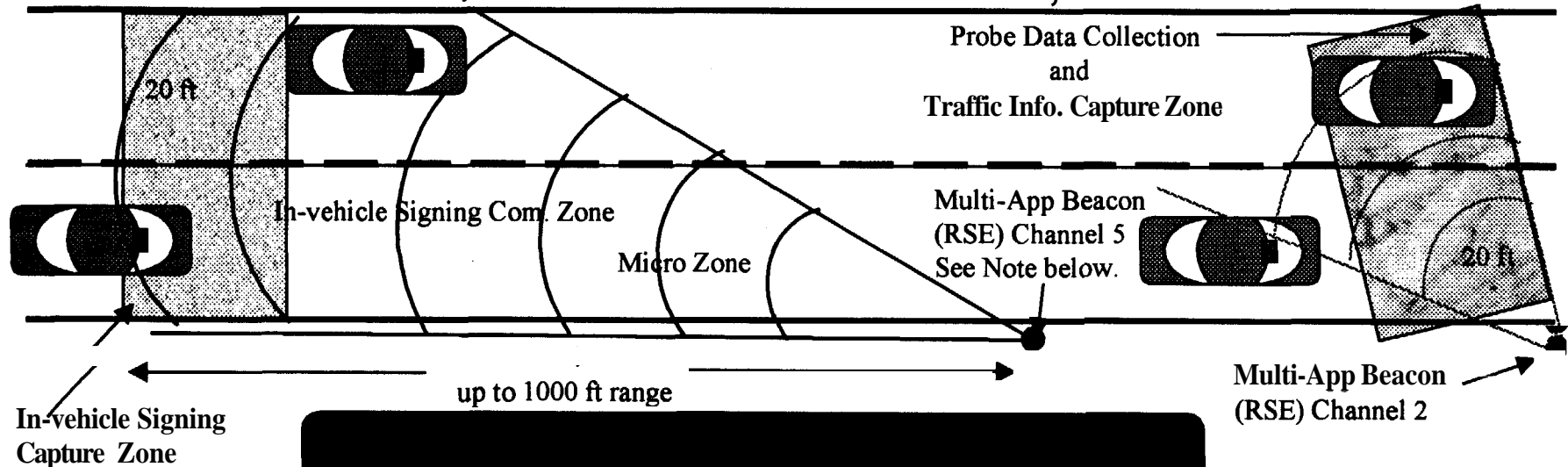
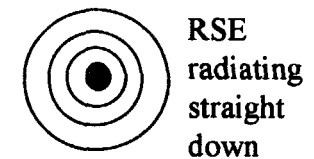


EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

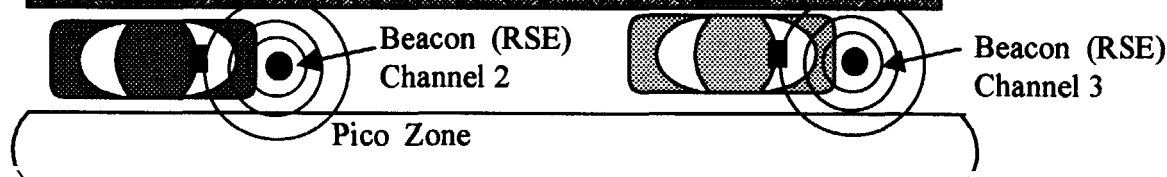
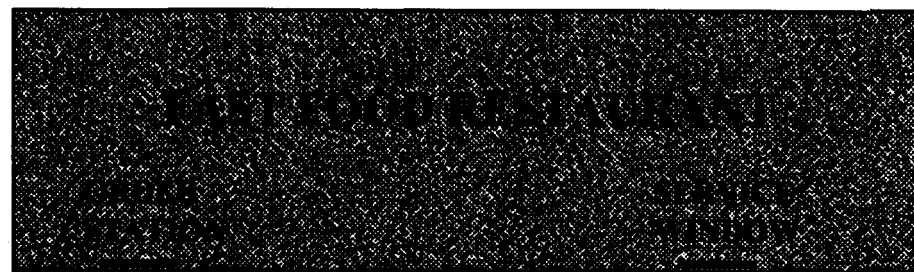
IN-VEHICLE SIGNING, PROBE DATA COLLECTION, TRAFFIC INFORMATION



- RSE on Channel 2
- OBE on Channel 2



Note: Changing to the next available channel when locating one zone directly after the other prevents interference.



Not to Scale

Narrowband Channelization

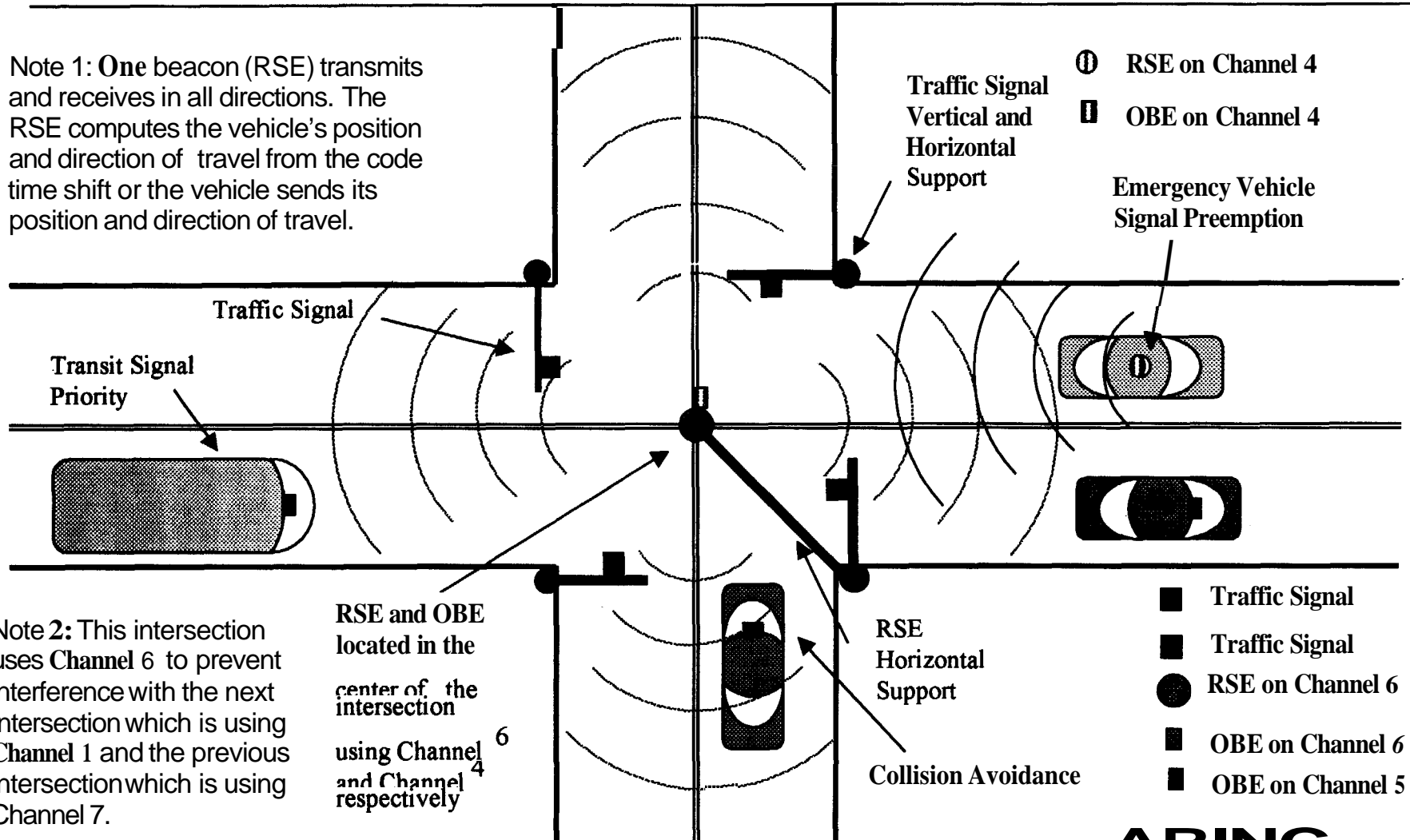
FAST FOOD PAYMENT

ARINC

EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

TRANSIT SIGNAL PRIORITY, PREEMPTION, and COLLISION AVOIDANCE

Note 1: One beacon (RSE) transmits and receives in all directions. The RSE computes the vehicle's position and direction of travel from the code time shift or the vehicle sends its position and direction of travel.



Note 2: This intersection uses Channel 6 to prevent interference with the next intersection which is using Channel 1 and the previous intersection which is using Channel 7.

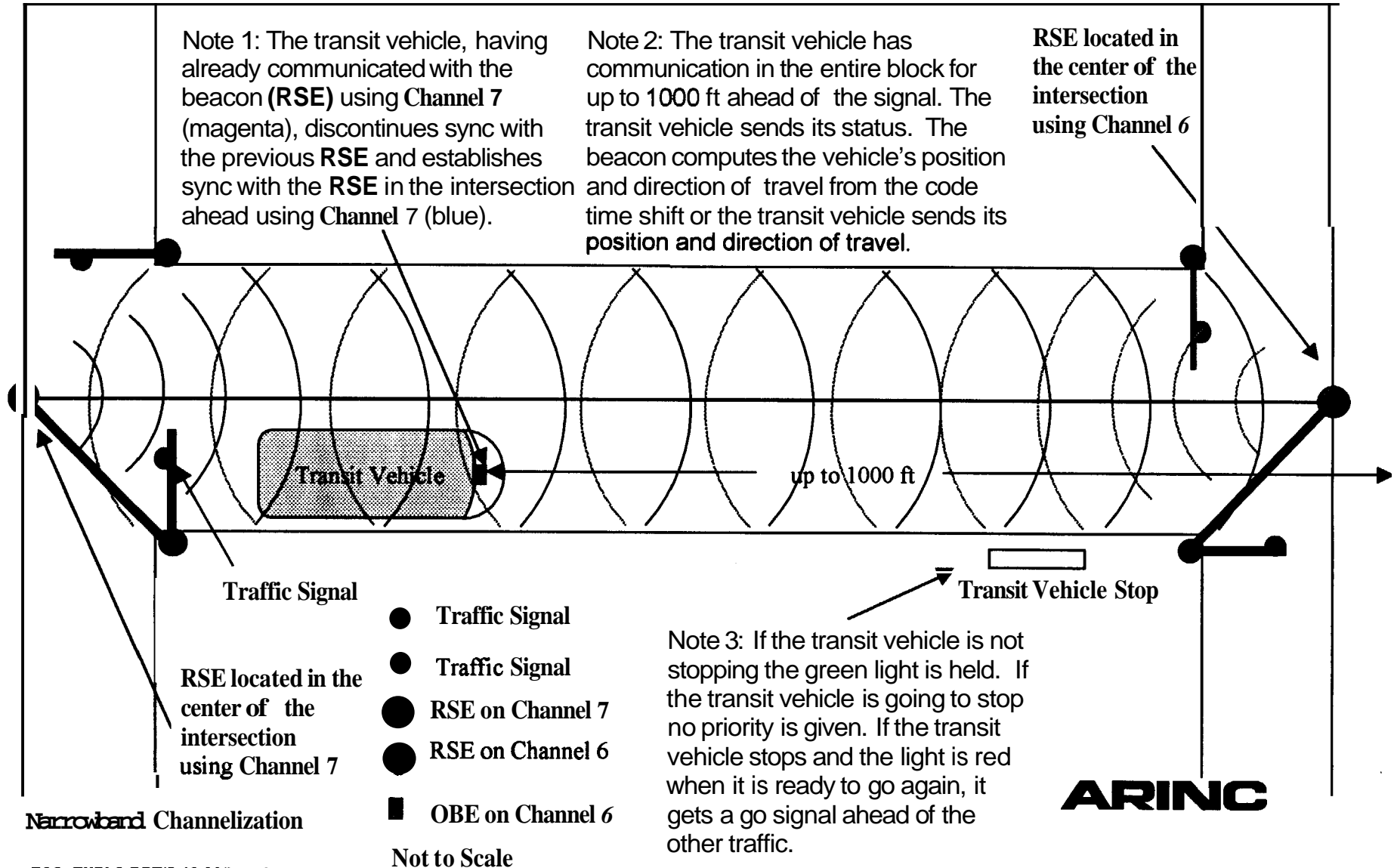
Narrowband Channelization

Not to Scale

ARINC

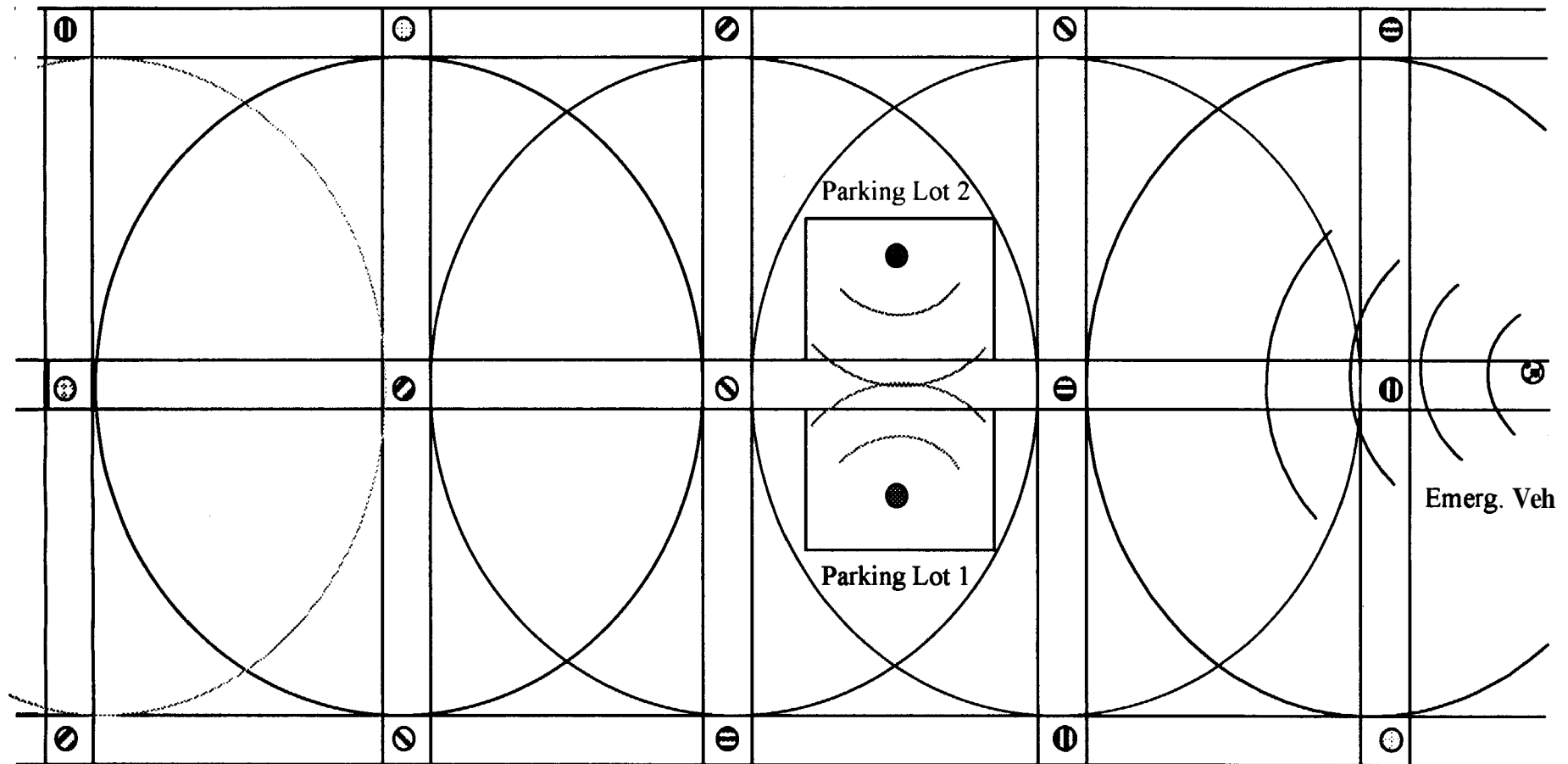
EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

TRANSIT SIGNAL PRIORITY SIGNAL SELECTION



EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

NARROWBAND URBAN CHANNEL DEPLOYMENT MAP



● Channel 1

● Channel 2

● Channel 3

⊗ Channel 4

⊞ Channel 5

⊡ Channel 6

⊘ Channel 7

⊙ Channel 8

⊖ Channel 9

○ Beacon

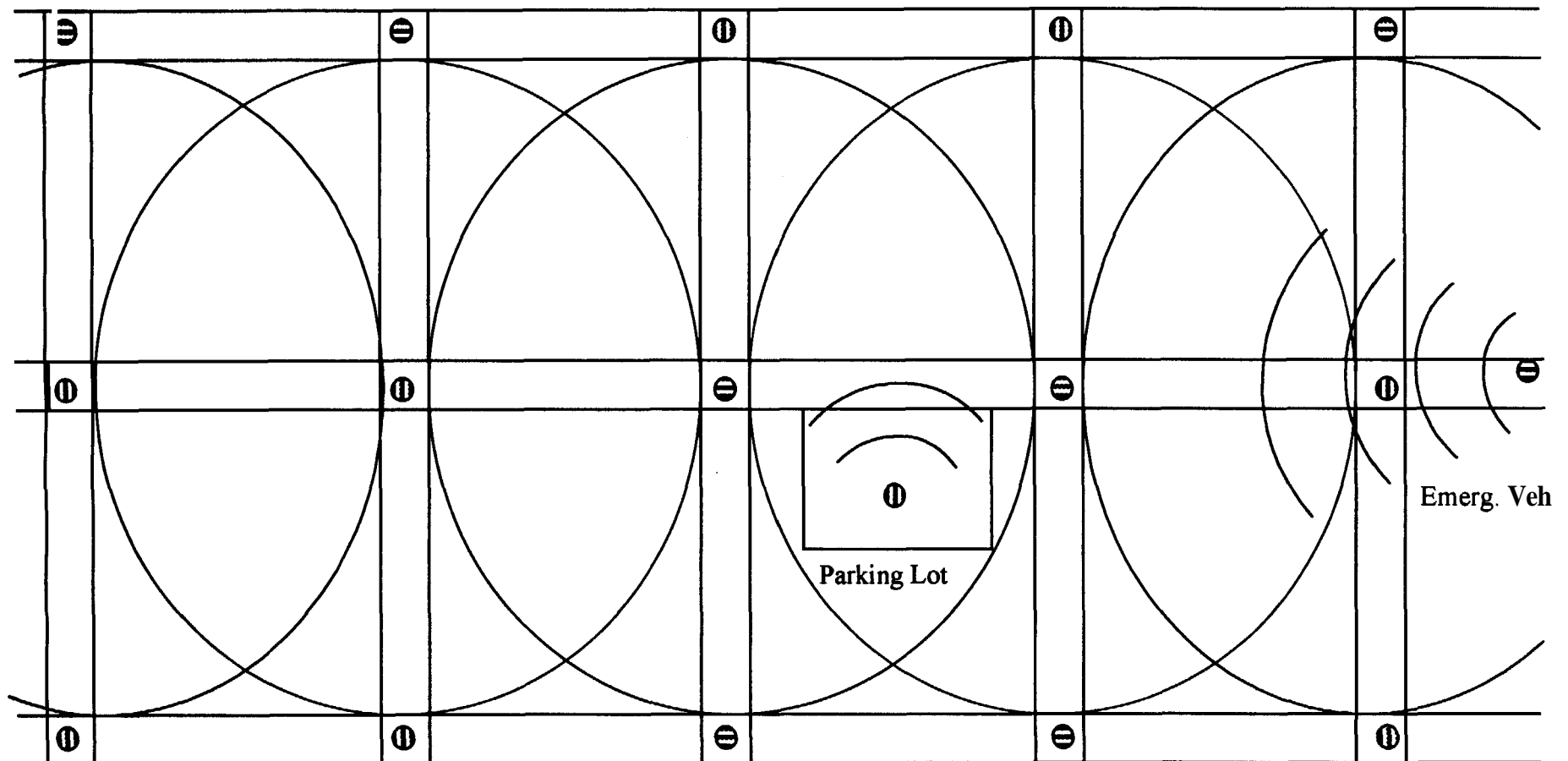
Not to Scale

Narrowband Channelization

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EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

WIDEBAND URBAN CHANNEL AND PN CODE DEPLOYMENT MAP



⊕ Channel 1 / PN 1

⊖ Channel 1 / PN 2

● Channel 1 / PN 3

Not to Scale

⊕ Channel 2 / PN 1

⊖ Channel 2 / PN 2

● Channel 2 / PN 3

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⊕ Channel 3 / PN 1

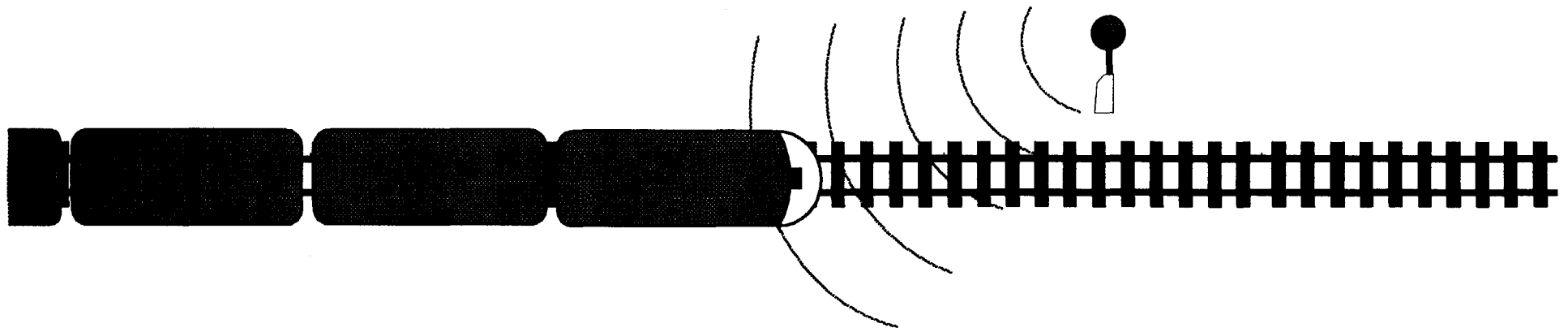
⊖ Channel 3 / PN 2

● Channel 3 / PN 3

Wideband Channelization

EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

RAILROAD DATABASE & REPAIR SERVICE RECORD TRANSFER



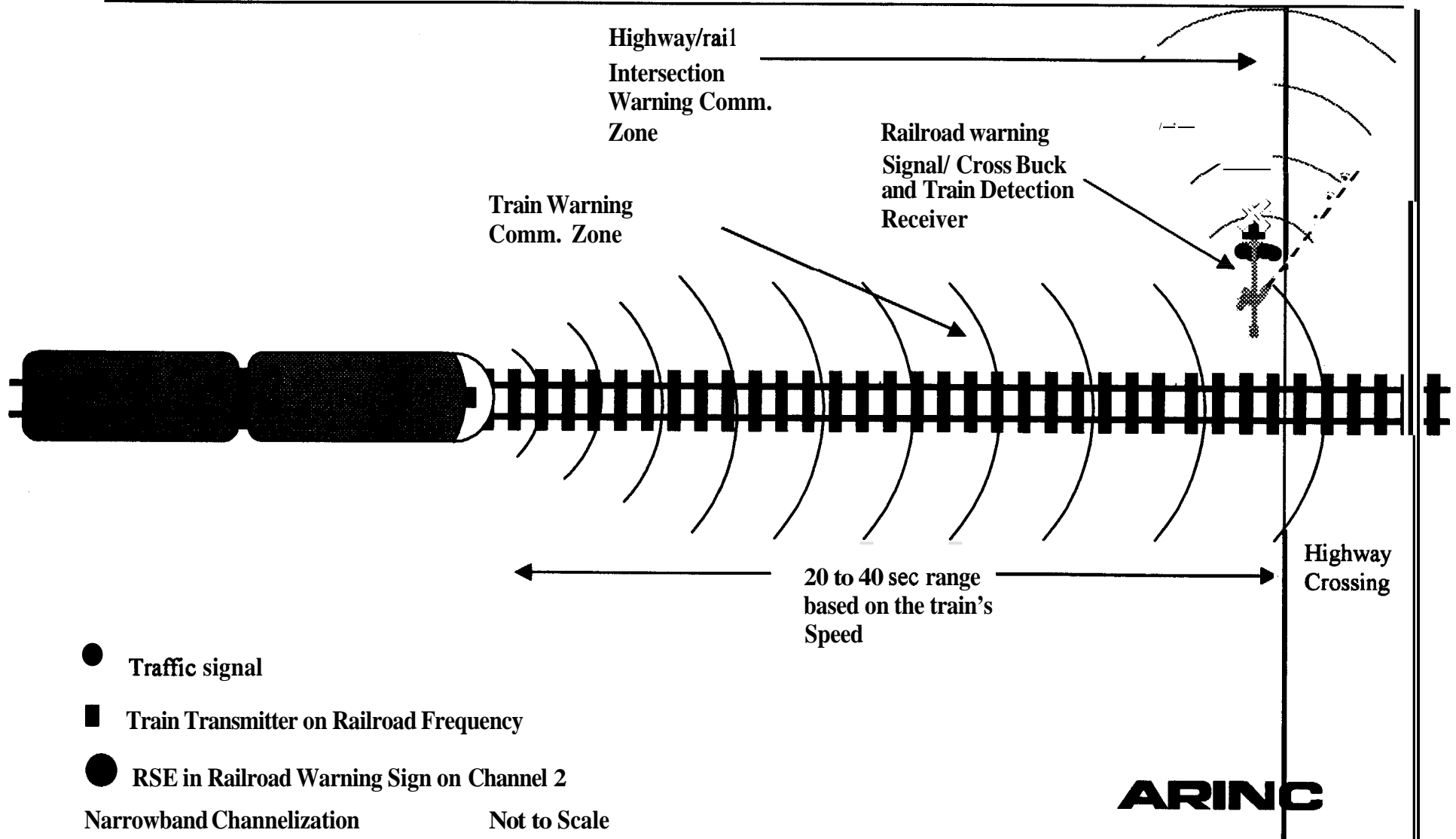
- RSE Data Transfer Beacon on Channel 7
- OBE on Channel 7

Not to Scale

Narrowband Channelization

EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

HIGHWAY/RAIL INTERSECTION WARNING

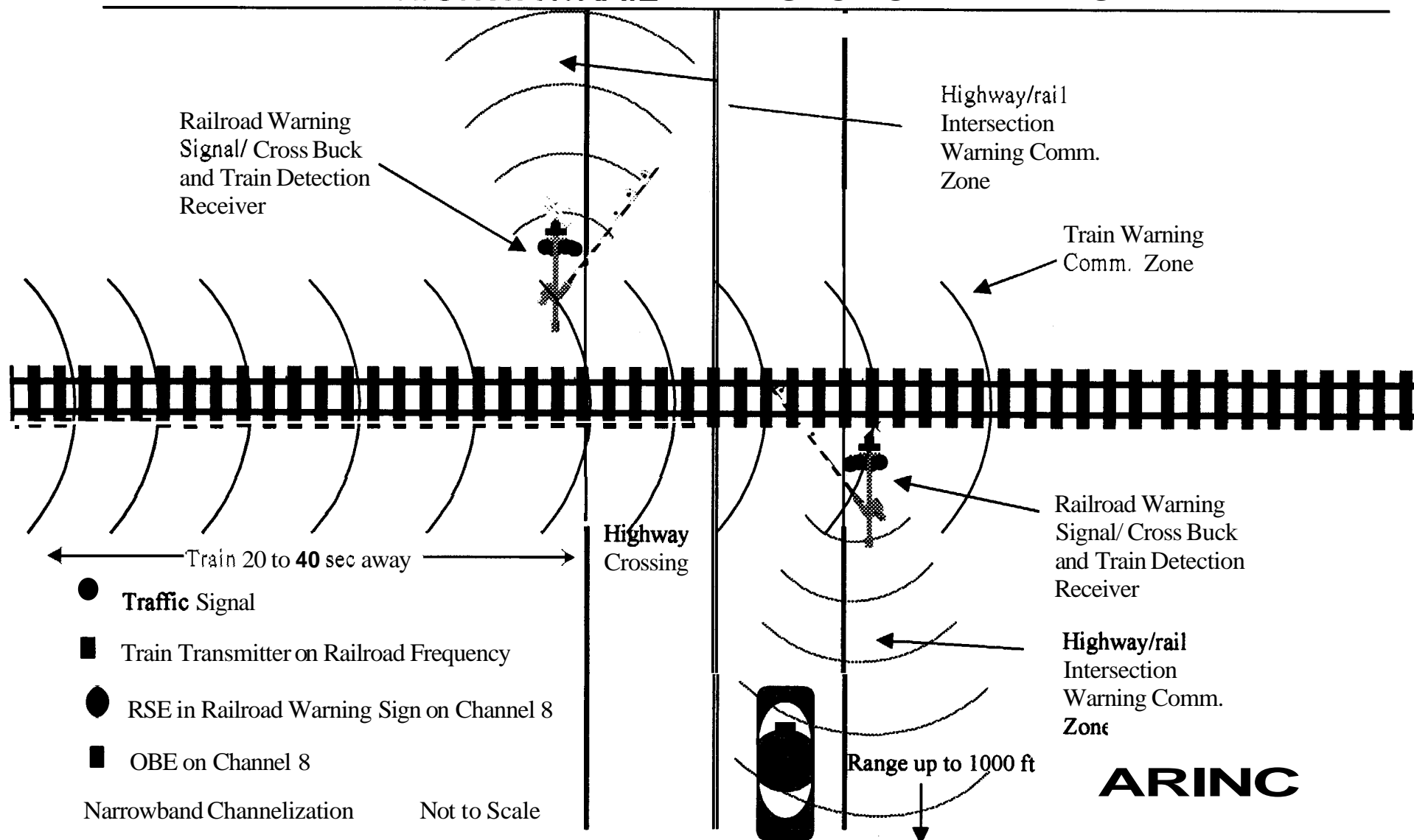


Narrowband Channelization

Not to Scale

EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

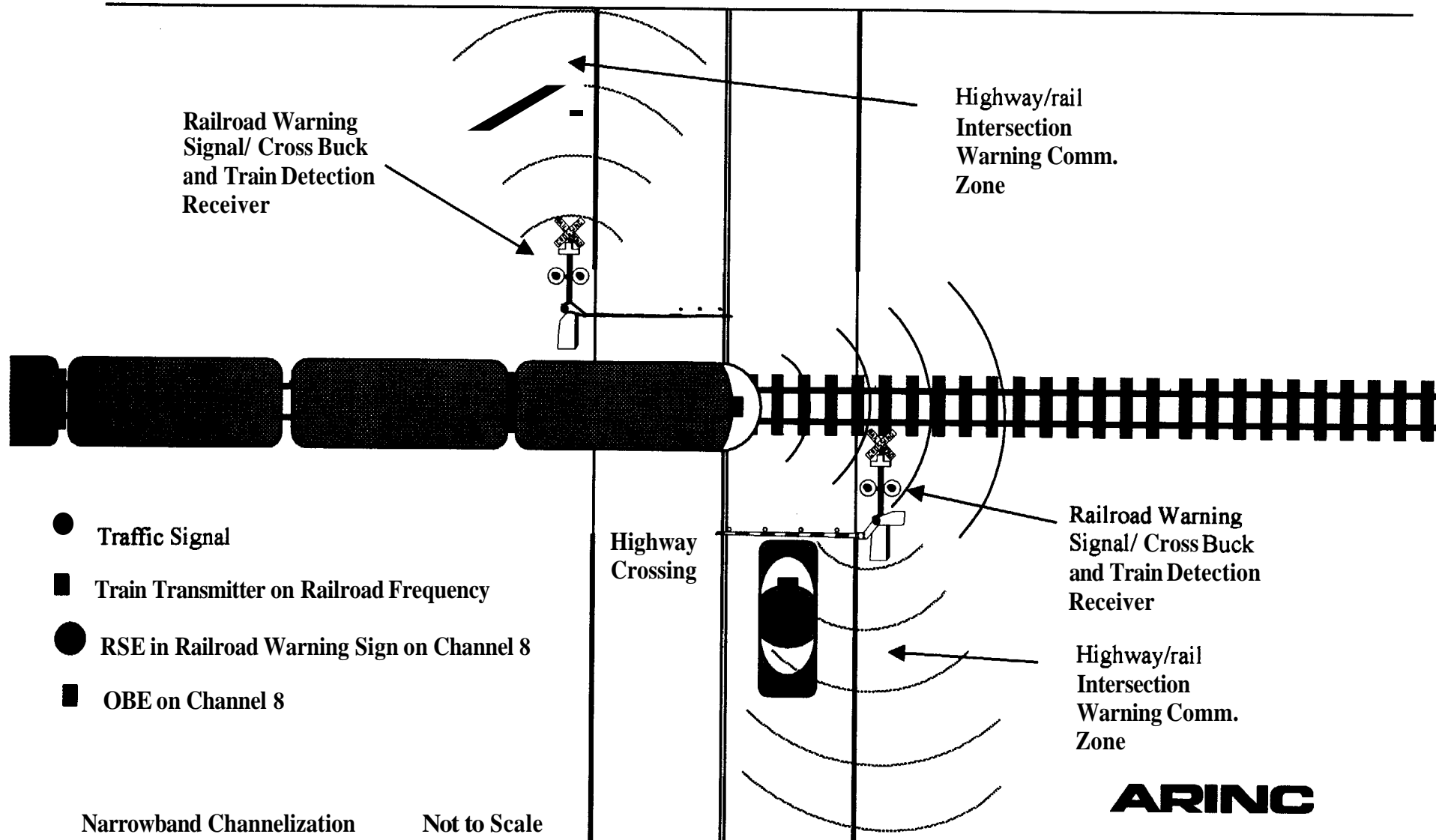
HIGHWAY/RAIL INTERSECTION WARNING



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EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

HIGHWAY/RAIL INTERSECTION WARNING



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EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

TOLL COLLECTION (Open Road)

RSEs are located on the gantry above the lanes using Channels 1, 2, and 3

Beacon Antennas (RSE)

☒ = capture zone

gantry

Pico Zones

- ☐ RSE on Channel 1
- ☐ RSE on Channel 2
- ☐ RSE on Channel 3
- OBE on Channel 1
- OBE on Channel 3

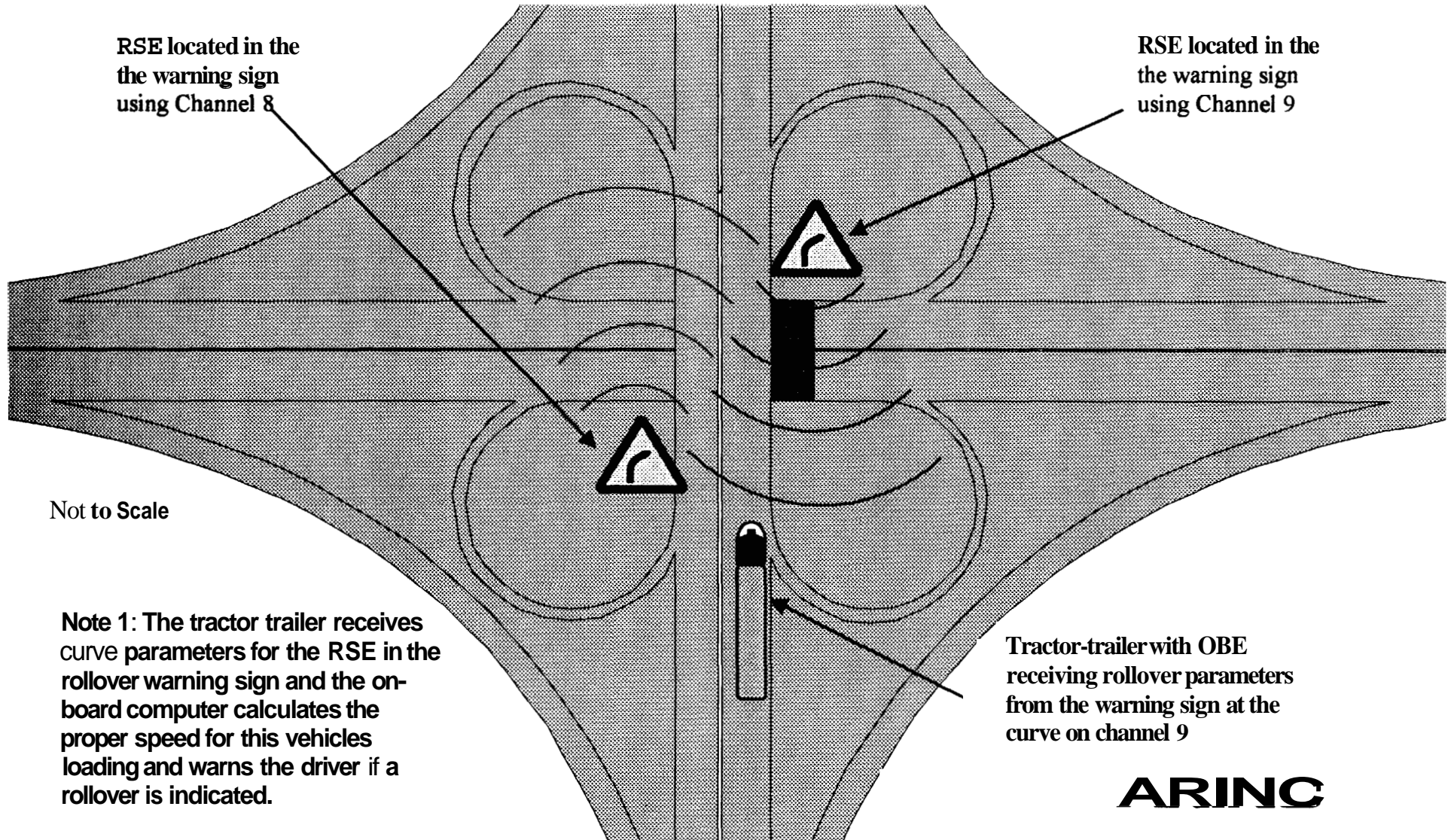
Note 1: Users are allowed to proceed at highway normal speeds while the toll is paid.

Not to Scale

Narrowband Channelization

EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

ROLL OVER WARNING



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5.9 GHz DSRC Standard Requirements Development

**Prepared for
ASTM
5.9 GHz DSRC
Task Group
Meeting
May 26-27, 1999**

5.9 GHz DSRC Requirements

Development Status as of 12 May 1999

- **First estimate is done**
- **All requirements were not addressed**
- **Receiving Additional input from stakeholders**
- **Estimating size of future security requirements**
- **Continuing Research on each application to complete, finalize, and substantiate the estimates**

REQUIREMENT ORGANIZATION

- **Common Requirements**
 - Stakeholder Requirements
 - Derived Requirements
- **Application Specific Requirement Categories**
 - Stakeholder Requirement Categories
 - Derived Requirement Categories
- **Application Specific Requirement Proposals**

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Common Stakeholder Requirements (Proposed)

- Nationally Compatible
- All Weather Operation
- Two-way (point to point) Communication
- One-way (roadside to vehicle) Communication
- Extremely low latency
- Secure (only authorized users can read transmitted data)
- Reliable (High MTBF and communications performance as indicated in the specific requirements)
- Maintainable (Low MTTR)
- Easy to use
- Scalable (grow from one to multiple lanes of service)
- Widely Installable (few incompatible sites)
- Multimodal (road, rail, aircraft [on the ground] and sea [canal, river, or port])

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Common Stakeholder Requirements (Proposed) (con't)

- **Non-Interference with 915 MHz systems**
- **Non-Interference to incumbent (primary allocation) 5.9 GHz systems**
- **Minimize interference with secondary allocation 5.9 GHz systems**
- **Tolerant of inadvertent interference from incumbent 5.9 GHz systems**
- **Market acceptable cost**

Common Derived Requirements (Proposed)

- **Communicate between potential radar pulses as much as possible.**
- **Minimize high angle radiation to stay below the aggregate radiation level required to prevent interference with satellite receivers.**

Application Specific Stakeholder Requirement Categories (Proposed)

- General Position -- OBE, in vehicle, obtains information from a Beacon while in a communications zone -- Yes or No
- Vehicle Detection -- Beacon obtains information from a vehicle in a communications zone -- Yes or No.
- Vehicle Location -- Beacon obtains information from a vehicle in a small communications zone -- Yes or No.
- Lane Discrimination -- Beacon only sends information to a specific lane or only obtains information from a vehicle in a specific lane in the communications zone -- Yes, No, or As necessary .

Application Specific Stakeholder Requirement Categories (Proposed) (con't)

- **Communication Performance in percent of successful transactions or message error rate.**
- **Traffic Speed in mph**
- **Traffic Density in vehicles/ hour/lane (v/h/l))**
- **Min. Vehicle Separation in ft.**
- **Min. OBE longitudinal separation in ft.**
- **Min. OBE lateral separation in ft.**
- **Beacon Density**

Application Specific Derived Requirement Categories (Proposed)

- **Transaction Size in bits (total downlink and uplink bits)**
- **Max. No. of Messages (required for a transaction)**
- **Max. Range in ft.**
- **Communication zone size in ft.**
- **Beacon Separation Distance in ft**

DSRC APPLICATION SPECIFIC REQUIREMENT PROPOSALS FOR THE FOLLOWING APPLICATIONS

- PROBE DATA COLLECTION
- TRAFFIC INFORMATION
- IN-VEHICLE SIGNING
- WORK ZONE SAFETY WARNING
- ROLLOVER WARNING
- EMERGENCY VEHICLE SIGNAL PREEMPTION
- TRANSIT VEHICLE SIGNAL PRIORITY
- HIGHWAY/RAIL INTERSECTION WARNING
- INTERSECTION COLLISION AVOIDANCE
- ACCESS CONTROL
- VEHICLE AND CARGO TRACKING
- WEIGH-STATION CLEARANCE
- INTERNATIONAL BORDER CLEARANCE
- ON-BOARD SAFETY DATA
- UNIQUE CVO FLEET MANAGEMENT
- TOLL COLLECTION
- PARKING PAYMENT
- RENTAL CAR PROCESSING
- GAS (FUEL) PAYMENT
- FAST FOOD PAYMENT
- PHARMACY DRIVE-THRU PAYMENT
- TRANSIT VEHICLE DATA TRANSFER
- DRIVER'S DAILY LOG
- VEHICLE SAFETY INSPECTION
- REPAIR-SERVICE RECORD and DATA TRANSFER
- RAIL ENGINE DATA TRANSFER
- RAIL ENGINE FUELING CONTROL
- TRUCK TRACTOR-TRAILER INTERFACE
- ELECTRONIC LICENSE PLATE

The following Proposals are based on the ETTM User's Requirements Document dated 1995, the CVO DSRC Requirements for ITS dated 1996, Traffic Volume data supplied by ITS-A, and discussions with manufacturers, FCC representatives and other sources as indicated. In addition, the following chart formats and many of the application definitions are from the Raytheon Briefing "Evaluation of DSRC Requirements and proposed System Capabilities" by Roger O'Conner, 8 Nov, 1996.

PROBE DATA COLLECTION

Traffic management centers (TMC) can monitor traffic flow parameters, such as density and link speed, by installing beacons along the monitored route at about ½ to 1 mile intervals. The OBE equipped probe vehicles can then be identified and the time recorded as they pass each beacon. This information is then used to compute the traffic density and link travel times.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- Yes.

Lane Discrimination -- As necessary.

Communications Performance -- 80%.

Traffic Speed -- 0 to **120** mph.

Traffic Density -- 3000 v/h/l - (1 to 8 lanes).

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- **6** ft (motor cycles) / 16 ft (other).

Min. OBE lateral separation -- 3 ft (motor cycles) / 10 ft (other).

Beacon Density -- nominally **1** per **2600** ft (occasionally **1** per 600 ft).

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PROBE DATA COLLECTION (continued)

DERIVED REQUIREMENTS

Communication Mode - Two-way - Beacon on Roadside.

Transaction Size -- 500 bits.

Max. No. of Messages -- 5.

Max. Range -- 50 ft.

Communication Zone Size -- < 20 ft.

Beacon Separation Distance -- 2600 ft .

TRAFFIC INFORMATION

As traffic data is developed from probe vehicles one of the benefits may be the feedback of link time and traffic density information by the probe beacons to the OBE equipped vehicles. This would allow drivers of these vehicles to take action where possible to avoid congestion.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- No.

Vehicle Location -- No.

Lane Discrimination -- No.

Communications Performance -- 99.995 %.

Traffic Speed -- 0 to 120 mph.

Traffic Density -- 3000 v/h/l - (1 to 8 lanes).

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 6 ft (motor cycles) / 16 ft (other).

Min. OBE lateral separation -- 3 ft (motor cycles) / 10 ft (other).

Beacon Density -- 1 per 2600 ft.

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TRAFFIC INFORMATION (continued)

DERIVED REQUIREMENTS

Communication Mode - ONE-WAY - Beacon on Roadside.

Transaction Size -- 500 bits.

Max. No. of Messages -- 5.

Max. Range -- 50 ft.

Communication Zone Size -- < 20 ft.

Beacon Separation Distance -- 2600 ft .

IN-VEHICLE SIGNING

In-vehicle signing refers to the display (and annunciation, where necessary) of available roadside sign information inside the vehicle. Beacon antennas mounted in sign structures or overhead gantries would deliver the data. Implementation is expected to include mostly variable message, warning, and some regulatory signs.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.
Vehicle Detection -- No.
Vehicle Location -- No.
Lane Discrimination -- No.
Communications Performance -- 99.995 %.
Traffic Speed -- 0 to 120 mph.
Traffic Density -- 3000 v/h/l - (1 to 8 lanes).
Min. Vehicle Separation -- 1 ft.
Min. OBE longitudinal separation -- 16 ft .
Min. OBE lateral separation -- 10 ft.
Sign Density -- ? ft.

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IN-VEHICLE SIGNING

(continued)

STAKEHOLDER REQUIREMENTS (continued)

Pass static and variable message sign data to the OBE in time for the average driver to take the proper action at all road design speeds (0 to **65** mph).

Do not add additional road hazards (posts) on the roadside, if it can be avoided.

Where possible, install beacon s on existing sign structures.

Install beacons beside the roadway with the proper lateral clearance in accordance with the Manual on Uniform Traffic Control Devices.

Install permanently mounted beacons behind the roadway guard rails where present.

DERIVED REQUIREMENTS

Communication Mode - ONE-WAY - Beacon on Roadside.

Transaction Size -- ??? bits.

Max. No. of Messages -- limited by transaction size.

Max. Range -- **1100** ft .

Communication Zone Size -- **20** to **100** ft.

Beacon Separation Distance -- Max. Range of preceding beacon. **125** to **1100** ft.

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WORK ZONE SAFETY WARNING

Work zone safety warning refers to the detection of a vehicle in an active work zone area and the display (and annunciation, where necessary) of available warning information inside the vehicle. Beacons with antennas mounted in sign structures or overhead gantries would detect the vehicle and deliver the warning data.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.
Vehicle Detection -- Yes.
Vehicle Location -- Yes.
Lane Discrimination -- Yes.
Communications Performance -- 99.995 %.
Traffic Speed -- 0 to 120 mph.
Traffic Density -- 3000 v/h/l - (1 to 8 lanes).
Min. Vehicle Separation -- 1 ft.
Min. OBE longitudinal separation -- 16 ft.
Min. OBE lateral separation -- 10 ft.
Sign Density -- ? ft.

WORK ZONE SAFETY WARNING (continued)

OTHER STAKEHOLDER REQUIREMENTS

Pass static and variable message sign data to the OBE in time for the average driver to take the proper action at all road design speeds (0 to **65** mph).

Do not add additional road hazards (posts) on the roadside, if it can be avoided.

Where possible, install beacon s on existing sign structures.

Install beacons beside the roadway with the proper lateral clearance in accordance with the Manual on Uniform Traffic Control Devices.

Install permanently mounted beacons behind the roadway guard rails where present.

DERIVED REQUIREMENTS

Communication Mode - ONE-WAY - Beacon on Roadside.

Transaction Size -- ??? bits.

Max. No. of Messages -- limited by transaction size.

Max. Range -- **1100** ft.

Communication Zone Size -- **20** to **100** ft.

Beacon Separation Distance -- Max. Range of preceding beacon. **125** to **1100** ft.

ROLLOVER WARNING

Rollover warning is implemented by using a roadside beacon to communicate the turn characteristics to approaching trucks, which, with on-board processing, determine if the truck is within safe operating parameters (speed and balance) for the turn.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- No.

Vehicle Location -- No.

Lane Discrimination -- Yes.

Communications Performance -- 99.995 %.

Traffic Speed -- 1 to 120 mph.

Traffic Density -- 1200 v/h/l typical max. (2400 v/h/l possible).

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 30 ft.

Min. OBE lateral separation -- 10 ft.

Beacon Density -- 1 per installation.